Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of	}	
	}	
Revision of Part 15 Rules of the Commission's	}	
Rules Regarding Ultra-Wideband	}	ET Docket No. 98-153
Transmission Systems	}	

Comments of A. Peter Annan, Gary R. Olhoeft,
Alan E. Schutz, and David L. Wright

We submit these proposed definitions and rules in response to the Notice of Proposed Rule Making (NPRM), FCC 00-163, and the request for comments on testing (performed by NTIA and others) in the proceeding referenced above.

The critical and beneficial uses of UWB geophysical devices have been pointed out in prior comments to the Commission. We have provided some highlighted items in Addendum A which summarizes many of the pertinent points.

The issue of potential interference of UWB ground penetrating radar (GPR) with global positioning systems (GPS) has also been addressed by many comments. GPR and GPS systems must often work together. Examples in Addendum B illustrate such uses. Our proposed rules also address reduced emissions limits in GPS bands.

The statement in NTIA Report 01-383 on page 8-38 that "The signal from Device E [a ground penetrating radar system] was apparently below measurement system noise and Part 15 measurements could not be performed." supports the anecdotal comments submitted elsewhere in these proceedings that decades of experience in using ground penetrating radar have not produced harmful (nor even noticeable) interference. Private testing (Addendum C) has confirmed that the most commonly available current commercial ground penetrating radar systems produce radiation into the air at levels lower than Part 15 Class A digital devices per Section 15.109(b).

Given these facts, we would like to propose the following definitions and modifications to the Part 15 rules to allow commercial ground penetrating radar systems to be tested and certified by the manufacturers, and then used on an unlicensed basis for beneficial public health and safety and other applications as already noted in other comments to these proceedings. GPR's will never be consumer items deployed in large quantities; they will be used in limited quantities, for short periods of time in any given location by professionals trained in their proper use. For some special applications, devices with higher power or other characteristics outside of these specifications might be desirable, and such devices should be licensed or requested under waivers appropriately. We do not intend that these proposals should apply to ultra wideband devices in general. We also propose that GPR systems used in boreholes and tunnels or with transducers otherwise entirely underground should fall under Part 15 Section 15.211 with this section being reworded to specifically encompass GPR when used in this context.

Lastly, we see no practical way to implement a proximity switch or detector as proposed in the NPRM that could not be easily defeated by a user. Further, the "ground" is not always "down" as discussed in several comments to these proceedings, and there are materials such as powder snow which would not have the strength to support a contact switch, other materials such as basalt lava flows which are so rough any switch would be scraped off, and yet other materials such as clayey soils in which some GPR transducers get more energy into the ground when lifted slightly above the surface (to provide better average coupling match) and thus less leakage into the air. It is certainly possible to educate users and have them employ a switch so that the GPR is only turned on when it is in use acquiring data and in contact with the material to be probed. In the future, a computer might be programmed to detect the change in coupling of the transducer in air compared to in close proximity to an appropriate material and turn the GPR off if not in close proximity. It is not immediately obvious how this can be easily achieved. Since different systems, transducers, modes of deployment and diverse situations will have markedly different requirements for minimizing spurious emissions, then a general requirement is to have a mechanism in place to prevent unattended long-term operation. The rules could require a mechanism which the vendor implements in the manner most suitable for the instrument application and which could be in the form of a dead-man switch, a proximity detector, a time out switch, or other suitable device.

Proposed Definitions

Ground Penetrating Radar (GPR)

Ground penetrating radar (GPR) is a device which exploits the forward or back scattering of electromagnetic energy to locate and measure the spatial distribution of physical properties within soil, rock, water, ice, wood, concrete, and similar materials, or locates or images objects buried in such materials. GPR devices intentionally radiate into such materials with only unintentional or spurious radiation into the air.

Ground Penetrating Radar Transducer

A ground penetrating radar transducer is a structure meant to intentionally transmit electromagnetic energy into the ground with deployment and coupling to the ground as specified by the manufacturer, but in no case further than one meter from the material to be measured. It contains design elements such as coupling materials or shielding to minimize unintentional and spurious emissions into the air.

Frequencies of Operation

The physics of electromagnetic wave propagation through common materials of interest (such as soil, rock, water, ice, wood, concrete, and asphalt) dictates that GPR's operate over a broad range of frequencies in order to obtain the penetration depth and resolution necessary to detect, locate, image, and measure the properties of buried objects and the materials within which they are buried. Natural materials have a wide range of possible properties that are highly variable with environmental parameters such as moisture content and temperature, and may not be predicted in advance. Because this variability in properties controls the frequencies necessary for proper GPR penetration and resolution, GPR's can neither avoid nor notch out any frequencies. Although GPR systems are intentional radiators into the ground, any emissions into the air are unintentional and spurious in the restricted bands and only intermittently for very short periods of time.

Average Power or Average Field

For impulse or short pulse GPR systems, the average shall be as specified in Part 15.35(c). For other types of GPR systems, the average shall be as specified in 15.35(a) and (b).

Peak to Average Ratio Limit

Peak to average ratio = -10 log10 [pulse width X PRF] dB with a maximum of max 60 dB

Pulse Repetition Frequency (PRF)

Counted average over 1 sec <500 kHz

Pulse Width

First and last time pulse envelope is at 10% of peak value

Proposed Rules

The general provisions of part 15 apply for unlicensed operation with the added definitions above and the following additional rules specific to ground penetrating radar.

Ground penetrating radar (GPR) systems shall be deployed in proximity to the ground (or material to be measured) as recommended by the manufacturer or required by these rules. Such deployments shall be made to maximize coupling of emissions into the ground and to minimize spurious emissions into the air, consistent with the proper operation of the equipment.

In order to minimize spurious emissions, when the GPR is not in normal operation, it shall be in an off or standby mode, making no emissions into either the ground or the air. To this end, a mechanism shall be in place to prevent unattended long-term operation of the system.

The average field strength of unintentional or spurious radiated emissions into air from ground penetrating radar systems shall be determined by measuring the GPR transducer while deployed as the manufacturer recommends on a concrete pad with no metallic reinforcing that has been cured for at least 3 months and with horizontal dimensions at least equal to twice the longest length of the GPR transducer and depth of concrete of at least one meter or one wavelength (in concrete at the center) which ever is the lesser. The average field strength of unintentional or spurious radiated emissions into air shall not exceed the following RMS averages with a peak to average ratio as given in the above definition.

Frequency of Emission (MHz)	**Average Field Strength uV/m RMS**	**Measured at distance (m)**
1-30	30	100
30-88	90	10
88-216	150	10
216-960	210	10
960-1200	300	10
1200-2000	30	10
>2000	100	10

(120 kHz measurement BW) (linearly extrapolate distance if other)

Measurements would be made using standard procedures as described in CISPR 16 or equivalent.

Respectfully submitted, 15 August 2001

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ENCLOSURES:

1) Addendum A – Beneficial Uses of UWB Geophysical Devices
2) Addendum B – GPR & GPS
3) Addendum C - Emissions Testing of GSSI GPR Products
4) Addendum D – Emissions Testing of Some Sensors & Software Inc. Products

ADDENDUM A

Beneficial Uses of UWB Geophysical Devices

Many comments have been submitted to the Commission on the critical role of geophysical UWB devices such as ground penetrating radar. Without being too detailed, we have included for reference a paraphrased summary of beneficial uses from Gary Olhoeft comments filed May 22, 2001 and a copy of comments to the Commission filed May 9, 2001 from Sally G. Zinke, President of the Society of Exploration Geophysicists. These two items indicate the breadth of usage and fundamental scientific nature of UWB geophysical measurements.

a) From Gary Olhoeft May 22, 2001

The following is a partial list of uses of ultra wideband electromagnetic geophysical methods for public heath and safety and the federal agencies who use them with typical frequencies:

Agricultural nonpoint source pollution	USDA, EPA, USGS	0.001 Hz – 1000 MHz
Depth of plow and root zone studies	USDA	100 MHz – 1000 MHz
Groundwater quality and quantity	USDA, USGS, EPA	1 kHz – 1000 MHz
Highway and bridge integrity	DOT FHwyA	0.01 Hz – 1500 MHz
Railroad roadbed integrity	DOD, DOT	400 MHz – 1000 MHz
Airport runway & taxiway integrity	FAA, DOD/AF/Navy	500 MHz – 1500 MHz
Utility detection, pipeline inspection	NTSB,DOE,WAPA	0.01 Hz – 1000 MHz
Power transmission assessment	DOE, WAPA	100 MHz – 900 MHz
Leaking underground storage tanks	EPA, DOE	1 KHz – 900 MHz
Coal mine safety & subsidence	DOI/OSM	1000 Hz – 500 MHz
Earthquake hazards	DOI/USGS	0.0001 Hz – 900 MHz
Volcanic hazards	DOI/USGS	0.0001 Hz – 500 MHz
Landslide hazards	DOI/USGS	1k Hz – 500 MHz
Dam safety	DOI/BuRec	100 MHz – 1000 MHz
Dike and levee safety	DOD/USArmy CE	100 MHz – 1000 MHz
Collapsed building response	FEMA	100 MHz – 900 MHz
Forensics and anti-terrorist	DOJ/FBI	100 MHz – 1000 MHz
Acid mine environmental assessment	EPA,DOI/USGS	0.001 Hz – 900 MHz
Avalanche victim recovery	DOI/NPS, USDA/FS	100 MHz – 900 MHz
Humanitarian demining activities	DOD	1 kHz – 1000 MHz
Unexploded ordnance detection	DOD/Army/Navy	1 kHz – 1000 MHz
Nonproliferation investigations	DOD,DOE	1 kHz – 1000 MHz
Nuclear power plant safety	NRC,DOE	500 MHz – 1500 MHz
Environmental contaminant tracking	EPA,DOI/USGS	0.001 Hz – 900 MHz
Critical infrastructure characterization	DOE, DOI, DOD	0.01 Hz – 1000 MHz
Radio transmitter siting soil mapping	FCC, DOD, USCG	9 kHz and up

There are many more commercial and scientific applications such as archeology, planetary exploration, utility locating, geotechnical construction assessment, ground water exploration, minerals exploration, oil exploration, and so forth.

b) From Sally G. Zinke May 9, 2001

Comments by the Society of Exploration Geophysicists

The Society of Exploration Geophysicists submits these comments in response to the Notice of Proposed Rule Making (NPRM), FCC 00-163, in the proceeding referenced above, and a more recent request for comments on testing by NTIA and others, and in response to recommendations and conclusions of others concerning proposed changes to Part 15 rules. The Society of Exploration Geophysicists (SEG) is the preeminent association representing applied geophysicists from the United States and around the world. The SEG has over 18,000 members employed who are active in the oil and gas, mineral, engineering, environmental, academic and government sectors. Many of our members could be adversely affected by FCC rulings on UWB uses of the electromagnetic spectrum and we wish our concerns to be noted.

Electromagnetic field methods form a key part of the geophysical approach to subsurface mapping and imaging in earth and earth related materials. For many decades this branch of science has used the fundamental characteristics of electromagnetic fields to probe the electrical properties of materials beneath the surface. Making such electrical property observations demands the use of electromagnetic fields; there is no other solution. In general, geophysicists use the electromagnetic spectrum from on the order of 10^{-4} Hz through to 10^{10} Hz with most measurement systems actively energizing the ground and being ultra wide bandwidth according to the FCC's NPRM on UWB. No one device covers the whole spectrum; most devices and methodologies span one to three decades of spectrum.

In the past, the geophysical needs have been mostly ignored in spectrum management although there has been input to the NTIA from the United States Geological Survey through the Department of Interior. In addition to our needs to measure electromagnetic fields in a scientific manner and use them in scientific analysis, geophysicists also need to use electromagnetic fields for communication and navigation. Many of our field survey methods need to acquire spatial positioning (e.g. GPS usage is now critical to our membership) and also to electronically transfer data from remote locations. As a result, we recognize the need to balance electromagnetic spectrum usage for communications and navigation against the need for fundamental scientific measurements of subsurface properties.

To date, geophysical electromagnetic systems have been non-intrusive in their usage of the electromagnetic spectrum. Although geophysical systems may create quite strong local fields, the transmission of such signals into the air is undesirable and minimized by the nature of coupling into the ground. Geophysical UWB sources are designed to energize the ground and are not communications devices.

In the course of rulemaking, we urge the Commission to recognize the following key issues.

1. Electromagnetic geophysical measurements are of a fundamental scientific nature and they play an essential role in everyday practical subsurface investigations. There is no alternate way of measuring these fundamental electrical properties.

2. Geophysical UWB sources are uniquely designed to energize the ground and must not be classified or treated in the same manner as communications devices.

3. Rules which are extremely onerous and require substantial paperwork, licensing and administration will have a huge adverse impact on our membership which is generally made up of individual practitioners, small groups of scientists, small manufacturers and service providers.

4. The unique manner of deploying transducers, which are closely coupled to the ground, makes representative measurement standards difficult and costly to replicate in a standard test facility. Standardized test procedures must be kept as simple and as low cost as is practical.

5. Impediments to novel geophysical applications will be minimized by using the unlicensed regulation approach as provided for unintentional radiators in Part 15. Sensible source power limits should be combined with the promotion of awareness of potential interference within our professional associations, vendor warning labels on devices and dissemination of "good practice" guides in user manuals to achieve regulation objectives.

We trust that the above information provides insight into our professional and industrial needs. As applied scientists, we recognize the need to be cognizant of spectrum usage and encourage our members to provide technical input to the Commission. Many of our members have provided constructive comment to the Commission individually and have cited the vast range of applications where our technologies are used with great benefit to society.

ADDENDUM B

GPR & GPS

As has been enunciated many times, GPR applications often require GPS. These technologies have been demonstrated to co-exist many times. The following examples show combined GPR and GPS systems in full operation. Many other examples can be cited.

Figure B-1 Centimeter resolution DGPS for precise location positioning for GPR transducer in utility mapping. The computer generates more RF emissions into the air than does the GPR. (Photo by Alan Schutz, GSSI).

Figure B-2: 500 MHz center-frequency impulse GPR used to map snow depth shown in GPS antenna location positioning mounted right on top of GPR antenna without interference to either (photo courtesy of Wintechnik, 3Dgeophsyics and SnowScan). In this photo the GPR is being used to locate avalanche victims.

ADDENDUM C

Emission Testing of GSSI GPR Products

Attached are several emission test reports from independent testing houses on commercial Ground Penetrating Radar units.

Below is a picture of GSSI's compact HandyScan, which operates at a center frequency of 1 GHz, with a PRF of 50 KHz. Attached is the report of a Japanese test house comparing it to FCC Part 15 Subpart B class B. This system is primarily used for locating the position and depth of reinforcing bars of various materials, as well as other utilities such as electrical wiring.

Figure C-1: GSSI's HandyScan

The photo below is of GSSI's Interragator II, a GPR system that is sold through Vermeer Manufacturing Co. It operates at 200 KHz PRF with a center frequency of 300 MHz. The test for Emission standard EN50081-2:1993 is attached.

This system is used to locate buried utilities, primarily to prevent destroying them with trenching and horizontal drilling machines.

Figure C-2: Interragator II

COMPANY	: 日本無線株式会社		REPORT NO.	: 01031364-11
MODEL NAME	: RCレーダー		STANDARD	: FCC Part15 Sub B
MODEL NO.	: NJJ-85A		CLASS	: B
POWER	: D.C.7.2A		DISTANCE	: 3m
	:		TEST MODE	: 通常動作モード
TEMP	: 20℃ 34%		ENGINEER	: T.Nomura
DESCRIPTION	: 製造番号：ED42434			
	:			

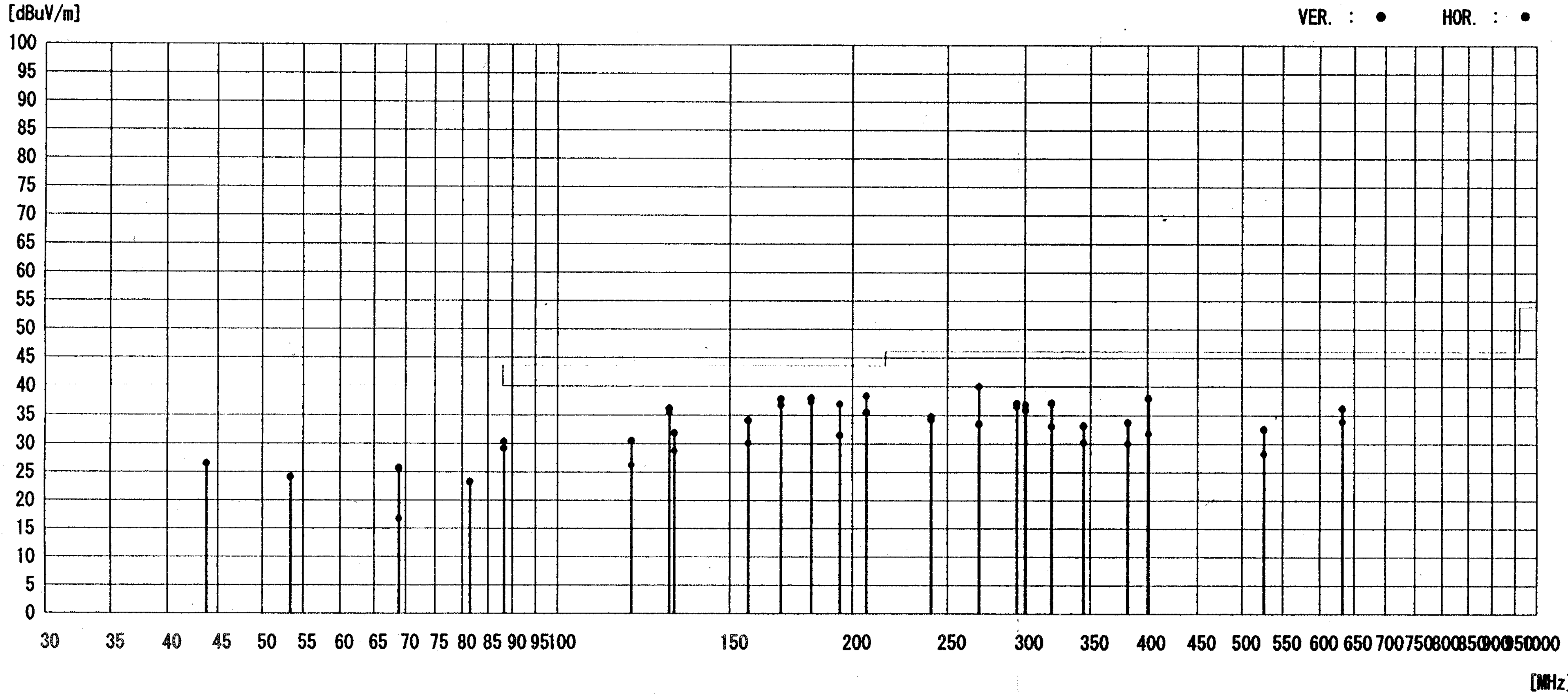
LIMIT1 : FCC Part15 Subpart B Class B (3m)
LIMIT2 :

	FREQUENCY	METER READING		FACTOR	FIELD STRENGTH		LIMITS	MARGIN	MARGIN	MEMO
		VER.	HOR.		VER.	HOR.		VER.	HOR.	
	[MHz]	[dBuV]	[dBuV]	[dB]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dB]	[dB]	
1	53.380	38.9		-14.9	24.0		40.0	16.0		
2	43.850	38.4		-12.0	26.4		40.0	13.6		
3	68.910	43.4	34.4	-17.8	25.6	16.6	40.0	14.4	23.4	
4	81.430	40.5		-17.3	23.2		40.0	16.8		
5	88.200	45.2	46.4	-16.1	29.1	30.3	43.5	14.4	13.2	BROAD NOISE
6	119.020	41.4	37.1	-11.0	30.4	26.1	43.5	13.1	17.4	
7	130.050	45.9	45.1	-9.8	36.1	35.3	43.5	7.4	8.2	
8	131.550	41.5	38.3	-9.7	31.8	28.6	43.5	11.7	14.9	
9	156.610	41.5	37.5	-7.5	34.0	30.0	43.5	9.5	13.5	
10	169.130	44.5	43.4	-6.7	37.8	36.7	43.5	5.7	6.8	
11	181.660	43.9	43.1	-6.0	37.9	37.1	43.5	5.6	6.4	
12	194.190	36.7	42.1	-5.2	31.5	36.9	43.5	12.0	6.6	
13	206.720	40.4	43.2	-4.9	35.5	38.3	43.5	8.0	5.2	
14	240.560	39.3	39.8	-5.1	34.2	34.7	46.0	11.8	11.3	
15	269.360	36.9	43.4	-3.5	33.4	39.9	46.0	12.6	6.1	
16	294.420	38.5	37.9	-1.5	37.0	36.4	46.0	9.0	9.6	
17	300.680	42.6	43.5	-6.8	35.8	36.7	46.0	10.2	9.3	
18	319.480	43.2	39.1	-6.1	37.1	33.0	46.0	8.9	13.0	
19	344.530	38.5	35.5	-5.4	33.1	30.1	46.0	12.9	15.9	
20	382.120	37.9	34.2	-4.3	33.6	29.9	46.0	12.4	16.1	
21	400.910	41.7	35.5	-3.8	37.9	31.7	46.0	8.1	14.3	
22	526.190	34.1	29.8	-1.6	32.5	28.2	46.0	13.5	17.8	
23	632.540	36.2	33.9	0.0	36.2	33.9	46.0	9.8	12.1	

対策 ①

EMC JAPAN Corporation　　NO1 SITE　　2001/03/16

COMPANY	: 日本無線株式会社	REPORT NO.	: 01031364-11	対策 ①
MODEL NAME	: RCレーダー	STANDARD	: FCC Part15 Sub B	
MODEL NO.	: NJJ-85A	CLASS	: B	
POWER	: D.C.7.2A	DISTANCE	: 3m	
	:	TEST MODE	: 通常動作モード	
TEMP	: 20℃ 34%	ENGINEER	: T.Nomura	
DESCRIPTION	: 製造番号：ED42434			
	:			
LIMIT1	: FCC Part15 Subpart B Class B (3m)			
LIMIT2	:			



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E	Electro
M	Magnetic
C	Compatibility

Test Report

Vermeer International BV

GPR System

INTERROGATOR II

Valid only with **ce-test** stamp below

Electro Magnetic Compatibility of Electrical- and Electronic Equipment.

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INTRODUCTION

This report contains the result of tests performed by **ce-test** for the purpose of a type approval for :

Name	Vermeer International BV
Address	Postbus 323
Post code	4458 AV
City/Town	's-Heer Arendskerke
Country	The Netherlands
Date	13 jan 2001
References	Dhr. Leonard Huissoon

Manufacturer

Name:	Vermeer MC
Address	PO BOX 200
	Pella, IOWA 50219
	United States of America
	Mr. Gary Young

Product

A sample of the following product was submitted for testing:

GPR System

Environment	Industrial
Manufacturer	Vermeer Manufacturing Company (IOWA-USA)
Trade mark	Vermeer
Type designation	INTERROGATOR II

Parts contained in the product are:

Type designations	INTERROGATOR II
Description	GPR System
Serial numbers	00047

This report is modeled after the European standards EN 45001 and the ISO/IEC directive 25. The consecutive numbering of the pages as required by these standards, has been stated in the upper left corner of each page, together with the report number. The contents of this report , if reproduced, shall be copied in full, unless special consent in writing for reproduction in part has been granted by **ce-test**.

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PRODUCT SPECIFICATION

The Interrogator II is an Vermeer OEM product, partially build by GSSI. Confidentiality of the INTERROGATOR II concept is GSSI's main concern. Therefore no circuit diagrams and other specifications will be avaialable for ce-test and Vermeer.

To reliably describe the version and revision of the Interrogator II, and to be able to compare future data found with this test report, detailed pictures are made available by GSSI and have been verified by ce-test.
As this is the only internal information available, this information has to be carefully compared to any product sample in the field in order to establish the validity of this test report.

GSSI is ready however, to handle over to a third party , such as a notified body the required further documentation, upon request and after signing a suitable non-disclosure agreement.

The Interrogator II is made up of readily available components of which one is the "antenna 30 Mhz" made by GSSI. It's this component that is further documented in the appendix using pictures.
This specification is enumerated below:

Component Description	Manufacturer	Type designation	Serial number	Accred	
Touchbook	Panasonic	CF-27	OJKSA02046	CE/TUV	
Cart Frame	GSSI	A70-368	000044		
Antenna 30 MHz	GSSI	300-MC	000047		
Batterij	Powersonic	PS121-80F	–		
Network card	Linksys	10/100 PC	942902		
Automobile adapter	Panasonic	PA1540-201A		CE/TUV	
Wheel sensor	Accu-coder	260-N2T-11-1000-0-0C	889168		

The touchbook is a Notebook PC compatible printer mounted on top of the Interrogator II chariot. It's pupose is to process raw date processed by the antenna box and transm,itted via the network to the touchbook.

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PRODUCT DOCUMENTATION:

For the production of this report the following product documentation was used:

Description:	Date:	Identification:	Sheets:
Operator manual	3-2000	o1_00	114 odd
Specification sheet	none	none	2LETTER

This documentation is available at the end of this test report.

The tests have been carried out in conformance with the following:

Standard:	EN 50082-2:1995	harmonized
	EN 50081-2:1993	harmonized

Emission standard EN 50081-2:1993
Immunity standard EN 50082-2:1995

The equipment has been classified as industrial equipment.

The emission testing was not in compliance with the test set up as described in CISPR document 22 . The reasons for this deviation -that leads to a Notified body involvement- are explained later in this test report.

The following tests from standards or parts of standards have not been fully carried out because of failure of the product:

None

The following tests from standards or parts of standards have not been fully carried out because of other reasons:

Test specification	Reason for exclusion	Remarks
EN 50081-2: MAINS	No mains connection	
EN 50082-2:1.3	No magnetic susceptable components	
EN 50082-2:2.1	No cables longer then 3 meters	Note 3.
EN 50082-2: 3.x	No process control cables	
EN 50082-2: 4.x	No DC-supply port	Note 3
EN 50082-2: 5.x	No mains port	
EN 50082-2: 6.1	No ground port	

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TEST PLAN

The Interrogator II is a ground penetrating "Radar" system. A considerable amount of energy is transferred into the ground by a suitable antenna. This antenna is shielded at all sides but the soil direction.
Therefore it could be classified as an intentional radiator. During analysis of the waveforms and spectrum of the transmitted waveforms, no transmitter suitable parameters such as carrier frequency and modulation type could be established, which makes compliance with any harmonized standard virtually impossible.
The pulse parameters of the transmit system are as follows:

Repeat frequency :	200 Khz
Pulse width :	3 nS
Duty Cycle	< 0.1 %
Send power level	1 Watt (as specified by manufacturer)
Send spectrum	essential wide band (70 MHz to 560 MHz approx)

As the actual emitted level of energy did not interfere with any receiver, an approach was made to have the Interrogator II pass standard EMC emission requirements according to the EMC-directive, and not classifying the Interrogator II as an intentional radiator. When the system was tested on an OATS measurement area the spectrum of the exceeded the industrial emission limits with more the 10 dB (over 51 dBuV/m at 10 meters). According to GSSI this was due to the reflection of the metal ground plane that inhibited the transmitted energy to protrude the ground.

Therefore we have decided to deviate from the OATS emission testing concept by measuring the actual emission levels on a representative operating situation being a standard road (see picture).

The emission levels were much less as the energy is absorbed by the soil. Using this way of testing the emission levels exceeded the house-hold levels of 30dBuV/m at a frequency of 114 MHz with 4 dB only.

This approach deviated from the test methods as described in the harmonized standards as specified in this test report. Therefore a "statement of opinion" from a notified body is required for this product to obtain permission to use the ce-mark. This Statement of Opinion is part of the Technical Construction Files according to article 10.2 of directive 89/336/EC, and this test report and compliance declaration alone may not be used without consulting such a Statement of Opinon.

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TEST SCHEDULE

Tests have been carried out according to the specifications as described in the applicable standards at the following date's :

March	OATS mesurements result in fail.
May 2001	2th initial measurements to determine outdoor results
May 30th	measurements using 100 Khz rep. rate
June 2001	19th Final emission measurements 200 Khz rep. rate

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FAILURE TO COMPLY:

NONE

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RETESTING

Several re-testing session were required to establish the final test situation replacing the OATS metallic groundplane by a real life soil.

No product modifications were introduced however.

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OBSERVATIONS AND COMMENTS

The Interrogator is very susceptible to radiated RF-fields in the range 80 MHz to 1000 MHz. This is due to the fact that the Interrogator II is principally a broadband receiver. Any disturbance field in this frequency range is visable on the Interrogator II screen as moiré or inhibits a working display completely. This lack of susceptability cannot be reduced without affecting the functionality of the interrogator II.

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CONCLUSION

During testing the product sample was found **IN COMPLIANCE** with the following standards or part of standards:

Standard:	EN 50082-2:1995	harmonized
	EN 50081-2:1993	harmonized

During testing of the product failed to comply with the following standards or part of standards:

Emission limits of EN 50081-2:1993

After the stated modifications laid out in this report have been carried out the following applies:

The equipment under test complied to the requirements of the tests as layed down in this test report.

The results of the type-tests as stated in this report, are exclusively applicable to the product sample as identified in this test report. **ce-test** does not accept any liability for the results stated in this report, with respect to the properties for product items not involved in these tests.

This report consists of a main module and several test modules. All pages have been numbered consecutively and bear the **ce-test** logo, the report number and date.

The total number of pages in this test report is 19.

The above conclusions have been verified by the following signatory:

Date	3-7-01
Name	Ing. G. Gremmen
Function	Manager
Signature	....

TEST REPORT EMC

Emission of Radiated RF-energy

Purpose of testing	CE-marking
Directive used	EMC-directive (89/336/EEC)
Standard used:	EN 50081-2:1993
Basic standard	CISPR 22
Class	Industrial
Test description	Emission of radiated RF-power
Applied to	Representative operating situation
Test Distance	10 meters
Limits	40 dBuV/m between 30 and 230 MHz 47 dBuV/m between 230 and 1000 Mhz (10 dB conversion between 10-30 meters assumed)
Equipment used	Chase CLB6111A antenna R&S ESV measuring receiver
Test setup	Conform CISPR 16
Tolerance:	Inaccuracy +/- 4dB

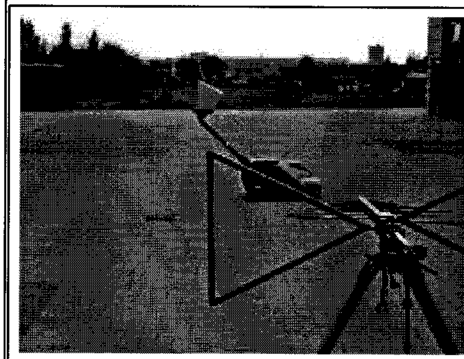
Measuring receiver	1
Antenna calibration	1
Read-out	0,5
Cable losses	1,5
Total	4

Frequency inaccuracy	1% FS
Conditions	--
Deviations of standard	No OATS used Test were executed on real life operating situation: Sand soil covered with standard paves Location : Kiotoweg Rotterdam NW
Remarks	Due to the absence of a reflective ground plane a 6 dB margin was added to the measuring results.
Device Under Test (DUT):	GPR System type INTERROGATOR II
External hardware	(CE-marked). none
External hardware	(not CE-marked) none

MEASURING RESULTS:

The EUT was placed on a distance of 10 meters from the antenna (see picture) The measurement values were corrected for antennafactor, cable losses and other inaccuracies. The Standards limits were corrected with - 6dB for the absence of a reflecting ground plane.

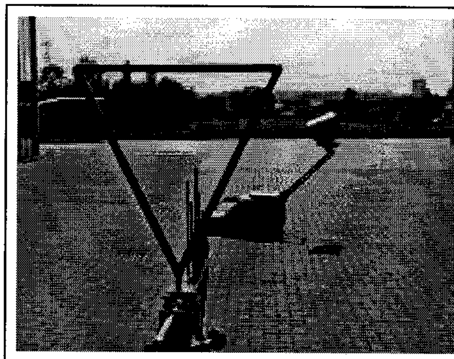
Measuring Distance		10 meter	EUT right side		
Polarization		Horizontal			
Mhz	dBuV	AF	Corr.	dBuV/m	Industr limi
53,3	11	7	4	22	34
74,8	11	6,8	4	21,8	34
82	12	7,3	4	23,3	34
113	12	11	4	27	34
120	12	12	4	28	34
162,27	12	10,4	4	26,4	34
182	10	9	4	23	34
227	12	11	4	27	34
244,73	13	12,5	4	29,5	41
Front side					
60	12	6	4	22	34
110	12	11	4	27	34
Back side					
120	12	12	4	28	34
164	12	10	4	26	34
189,3	12	9	4	25	34



All emission components are broadband emissions, and the noted frequencies are measured on the top of wide band spectrum lobes. As the repetition frequency of the Interrogator is 200 Khz , emssion spectrum lines are separated 200 Khz only.

The spectrum measured at vertical antenna polarization and miscellaneaous orientations of the EUT.

Measuring Distance 10 meter			EUT right side			
Polarization		**Vertical**				
Mhz	dBuV	AF	Corr.	dBuV/m		Industr limi
63	15	6,2	4	25,2		34
76	13	6,8	4	23,8		34
120	11	12	4	27		34
150	10	11	4	25		34
155	13	10,5	4	27,5		34
228	10	12	4	26		34
258	10	14	4	28		41
293	10	13,5	4	27,5		41
Left side						
45	14	10	4	28		34
Back side						
54	16		4	20		34
85	14	6,3	4	24,3		34
111	14	11	4	29		34
114	18	11,3	4	33,3		34
141	12	11,5	4	27,5		34
180	16	9	4	29		34
225	11	9,5	4	24,5		34
244	13	12,6	4	29,6		41
263	14	12,2	4	30,2		41
313	12	14	4	30		41



Conclusion Emission of Radiated RF-energy

De EUT is compliant with the applied standards.

TEST REPORT EMC

Immunity to RF Electromagnetic field

Purpose of this test	CE-marking.
Directive's used	EMC-directive (89/336/EEC)
Standard used	EN 50082-2:1995
Basic standard	EN 61000-3-3
Performance class	A
Manufacturers degradation	Accuracy better then 5%
Test description	Immunity to RF-Electro-Magnetic field
Test applied to	Operational set up of the product.
Mains specification	NA
Frequency range	80 MHz to 1000 MHz.
Equipment used:	R&S SMY-01 Kalmus 10 W amplifier Chase CLB6111 antenna
Location	CHAM delft.
Test setup	ACC. EN 61000-3-3
Differences to standard	Modulated field 80% AM / 1 kHz.
Field amplitude	10 V/m
Tolerance	Amplitude 6 dB.
Frequency inaccuracy	10 PPM
Conditions	Antenna / EUT distance 1 m.
External hardware	*(ce-marked)* none
External hardware	*(not ce-marked)* none
Remark	none
Cable setup:	

TEST RESULTS

Immunity to RF-Electro-Magnetic field

The frequency range 80-1000 MHz is tested in steps with increasing frequency of 1% per step . At every frequency the field amplitude is adjusted using a calibration table.
Frequency range : 80 MHz --- 1000 MHz In addition to the stepwise testing a full gliding scan has been performed making sure the field amplitude never gets lower then the test limit.

The Interrogator is very susceptible to radiated RF-fields in the range 80 MHz to 1000 MHz. This is due to the fact that the Interrogator II is principally a broadband receiver. Any disturbance field above 100 mV / meter in both polarazations in this frequency range is visable on the Interrogator II screen as moiré or makes the image useless.

As the function of the Interrogator II is essentially that of a broadband receiver, specifying functional limits at 10 V/meter is impossible. This test is therefore not applicable/suitable to the type of equipment.

Conclusion Emission of Radiated RF-energy

De EUT is compliant with the applied standards.

TEST REPORT EMC

Electro Static Discharge test

Purpose of testing	CE-marking
Directive used	EMC-directive (89/336/EEC)
Standard used EN 50082-2:1995	
Basic standard	EN 61000-4-2.
Test description	Electro Static Discharge test
Performance class	Class B
Mains specification	NA
Applied to	Metal parts accessible (contact discharge) Approaching method (device excluding cables) Approaching method (HCP and VCP)
Equipment used	Keytek ce-master:
Test set up	ACC. to IEC 1000-4-2 conform
Tolerance Pulse shape	+/- 10% Amplitude + 10%
Conditions	
Deviations from standard	equipment placed on wooden pallet approx 10 cm high.
External hardware	*(ce-marked)* none
External hardware	*(not ce-marked)* none

TEST RESULTS

Electro Static Discharge test

EUT operating.

While approaching EUT miscellaneous sides of the EUT are directed.

10 Air discharges of 8 kV in either polarity on EUT.
Air discharges on plastic enclosure are not possible.
Air discharges are done on metal frame : points left and right.
Discharges were made on metal fram points left and right and on the enclosure of the touchbook notebook.

Result:
The EUT does not go into permanent failure as mend in the stated criterion type B.

No discharges were made on the connector pins.

10 Air discharges of 8 kV in either polarity on VCP and HCP (total 40 discharges)

Result:
The EUT does not go into permanent failure as mend in the stated criterion type B.

10 contact discharges at 4 kV in either polarity to accessible metal parts.
Contact discharges on plastic enclosures are not possible.
Discharges were made on metal fram points left and right and on the enclosure of the touchbook notebook.

Result:
The EUT does not go into permanent failure as mend in the stated criterion type B.

10 contact discharges of 4 kV in either polarity on VCP and HCP (total 40 discharges)

RESULT:

The EUT does not go into permanent failure as mend in the stated criterion type B.

Remarks: Before starting the tests sensible areas were scanned using a 20 discharge per second rate.
No sensible points were detected, therefore the above tests on the metal frame are pro forma only.

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Appendix I

Measurement results for a total of 0 pages.

Appendix II

Customer documentation according to the following table:

Description:	Date:	Identification:	Sheets:
Operator manual	3-2000	o1_00	114 odd
Specification sheet	none	none	2LETTER

END OF TEST REPORT

==

010113/INTII/EMC

We,

Vermeer International BV

(Supplier's name)

Postbus 323
4458 AV 's-Heer Arendskerke
The Netherlands

(supplier's address)

declare under our sole responsibility that the product:

GPR System type INTERROGATOR II

Name, type or model, batch or serial number, possibly source and number of items.

to which this declaration relates in conformity with the following European, harmonized and published standards at date of this declaration:

Standard: EN 50082-2:1995 harmonized
EN 50081-2:1993 harmonized

Tile and or number and date of issue of the applied standard(s)

following the provisions of the Directives (if applicable):

EMC-directive : 89/336/EEC

Amendment to the above directive: 93/68/EEC

This declaration of Conformity is suitable to the European Standard EN 45014 *General Criteria for supplier's Declaration of Conformity*. The basis for the criteria has been found in international documentation, particularly in ISO/IEC, Guide 22, 1982, *Information on manufacturer's Declaration of Conformity with standards or other technical specifications*

These conclusions are based on test reports:

010113/INTII/EMC
ce-test PO box 563 2600 AN Delft

test report number, date and name of test house

's-Heer Arendskerke,

Place and date of issue

P.J. Sturm

name of responsible for CE-marking

jul 0107-03-01

ADDENDUM D

Emission Testing of Some Sensors & Software Inc. Products

Attached are testing results from some of Sensors & Software Inc.'s products. Test results which span the most common GPR applications are provided.

Important points to note are

a) Emission levels as measured increase as frequencies decrease and support the submission of Annan (September 9, 2000) to the Commission that allowable emissions from a GPR should increase as frequency decreases.

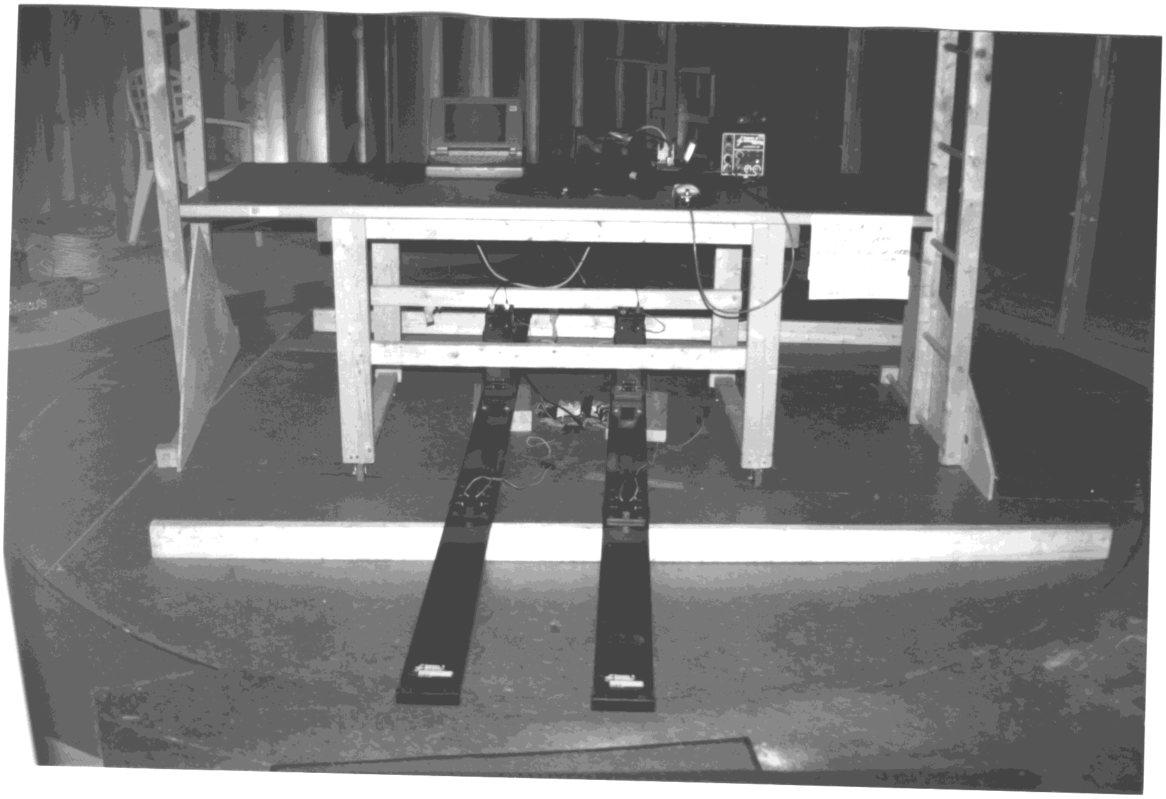
b) All test measurements reported are made over a metal ground plane which is not typical of GPR use and will always yield higher than normal emissions.

c) The computers in the systems, which are integral components of the systems, are often the source of measured emissions and not the actual GPR emitter. This result is the motivation for requesting Part 15 Digital Device emissions levels when testing GPR's.

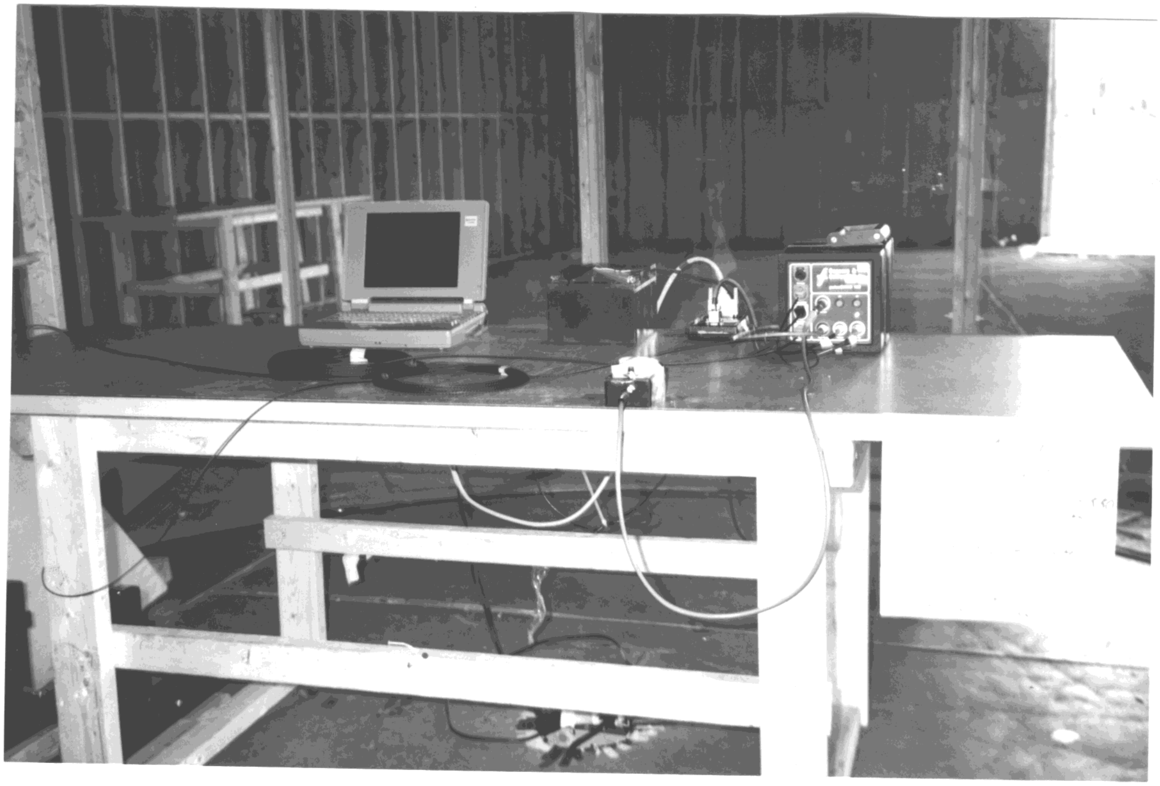
d) Peak and quasi-peak tests yield similar results. Average emission measurements of all GPR's tested could not be detected in the background noise.

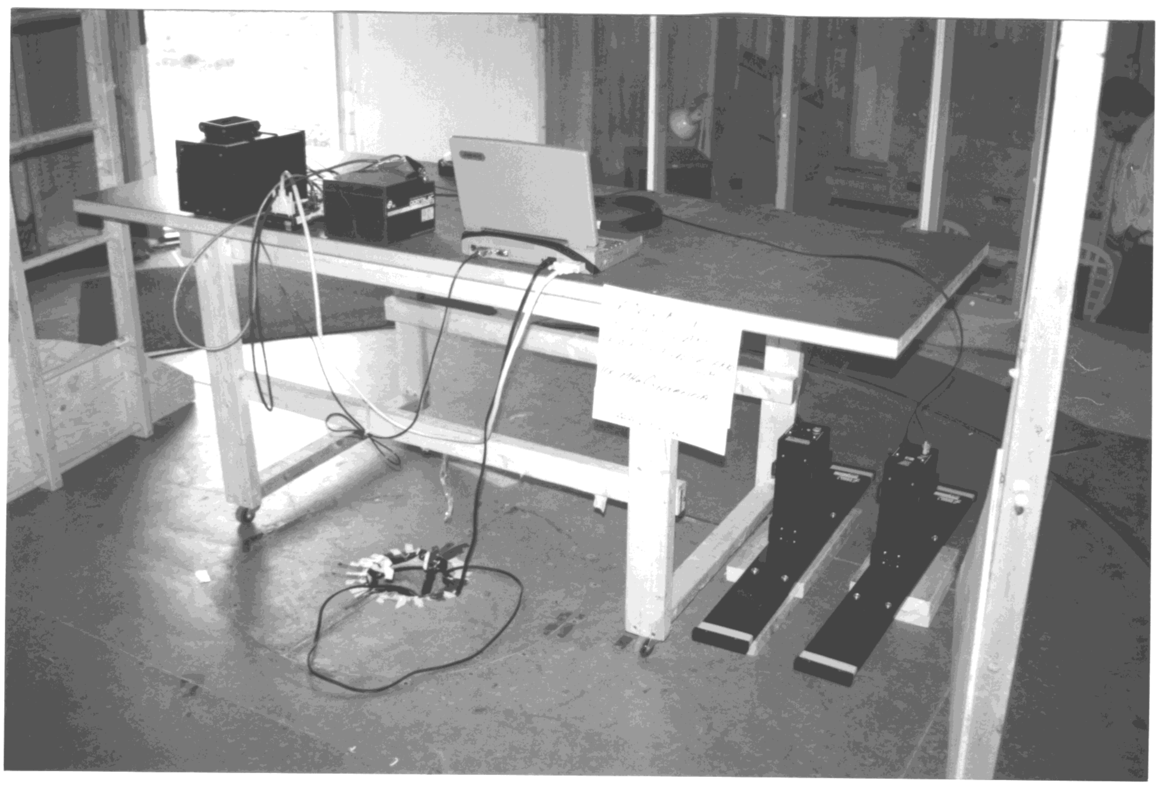
TEST SETUP FOR RADIATED EMISSIONS MEASUREMENTS
(tests were performed at the Open Field test Site located in Oakville, Ontario, Canada)

PULSE EKKO 100B- 25 MHz/ 400 Volt Pulser,



PULSE EKKO 100B- 100 MHz/ 400 Volt Pulser,





4.2. RF Radiated Emissions Measurements

PRODUCT NAME: Pulse EKKO 100B (25, 50, 100, & 200 MHz and 400 Volts/ 1000 Volts Pulser),
Model No.: 100B
CISPR CLASS A (GROUP 1)

CISPR 11, Para. 5.2.2, Table IIIA,
The test unit shall meet the limits of Table IIIA. If the reading on the measuring receiver shows fluctuations close to the limit the reading shall be observed for at least 15 seconds at each measurement frequency; the highest reading shall be recorded with the exception of any brief isolated high reading which shall be ignored.

Limits of Radiated Disturbance
@ 30 M in the Frequency Range 30 MHz - 1000 MHz
for Class A (Group 1) Equipment

FREQUENCY (MHz)	FIELD STRENGTH LIMIT @ 30 Meters (dBuV/m)
0.15 - 30	under consideration
30 - 230	30.0
230-1000	37.0

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 23±3 oC
- Relative humidity: 50±5 %
- Atmospheric Pressure: 100±5 kPa

POWER INPUT: 12 Vdc

TEST EQUIPMENT:
1. **EMI Receiver System/Spectrum Analyzer**, Hewlett Packard, Model 8546A, Input +25dBm max., 9KHz-5.6GHz, 50 Ohms, built-in Peak, Quasi-Peak & Average Detectors, Pre-Amplifier and Tracking Signal Generator. This System includes: (1) HP 85460A RF Filter Section, S/N: 3448A00236 and (2) HP 85462A Receiver RF Section/Display, S/N: 3520A00248.
2. Spectrum Analyzer, Adventest, Model R3271, S/N: 15050203, 100 Hz to 32 GHz)
3. Microwave Amplifier, HP, Model 8349A, SN: 2340A00206, Frequency Range 1 to 22 GHz, 30dB gain nominal.
4. Active Rod and Field (Monopole), Emco, Model 2201B, S/N: 3532, Frequency Range: 30 Hz - 50 MHz.
5. BiconiLog Antenna, Emco, Model 3142, SN 10005, 30-2000 MHz @ 50 Ohms.
6. Log Periodic Antenna, AH System, Model SAS-200/518, SN: 343, Frequency Range: 1GHz-18GHz.
7. FCC Listed Open Field Test Site.

METHOD OF MEASUREMENTS: Refer to CISPR 11.

Scans are made by using spectrum analyzer system with the resolution bandwidth set to 120 KHz and the detector set to PEAK, over the frequency range 30 MHz to 1000 MHz. If the quasi-peak limit is met when using a peak detector receiver, the measurements using quasi-peak detector shall be deemed to meet and the measurement with the quasi-peak detector is un-necessary.

All measurements were recorded in WORST CASE:

- The device is operated in all conditions at all working modes.
- The antenna is searched over a height of 1 to 5 meters for the maximum RF level.
- The turn-table is rotated for 360 degrees to search for the maximum RF level.

TEST RESULTS: Conforms

TEST PERSONNEL: Vinh Ngo

TEST DATE: July 9, 1996

MEASUREMENT DATA:

RADIATED EMISSIONS (@ 30 METERS)

REMARKS

- *All rf emissions from 30 to 1000 MHz were scanned, and all emission levels greater than 30 dBuV/m were recorded.*
- *For Frequency range 30 - 1000 MHz*
  - ◊ *Peak Detector, 120 KHz RBW, 100KHz VBW*
  - ◊ *CISPR QUASI-PEAK, 120KHz RBW, 1MHz VBW.*
- *For Frequency > 1 GHz*
  - ◊ *Peak Detector, 1 MHz RBW, 1 MHz VBW*

PULSE EKKO 100B- 25 MHz/ 400 Volt Pulser,

FREQUENCY (MHz)	RF LEVEL (dBuV/m)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	LIMIT (dBuV/m)	MARGIN (dB)	PASS/ FAIL
49.5	20.1	PEAK	H	30.0	-9.9	PASS
49.5	27.4	QP	V	30.0	-2.6	PASS
50.0	25.6	PEAK	H	30.0	-4.4	PASS
50.0	28.1	PEAK	V	30.0	-1.9	PASS
64.0	23.8	PEAK	H	30.0	-6.2	PASS
64.0	28.7	QP	V	30.0	-1.3	PASS
75.0	22.6	PEAK	H	30.0	-7.4	PASS
75.0	28.7	PEAK	V	30.0	-1.3	PASS
125.0	27.8	PEAK	V	30.0	-2.3	PASS
129.7	27.2	PEAK	H	30.0	-2.8	PASS
129.7	28.1	QP	V	30.0	-1.9	PASS
150.0	28.3	PEAK	V	30.0	-1.7	PASS
175.0	25.0	PEAK	V	30.0	-5.0	PASS
182.4	24.0	PEAK	H	30.0	-6.0	PASS
182.4	27.0	QP	V	30.0	-3.0	PASS
200.0	29.0	PEAK	V	30.0	-1.0	PASS
225.0	21.3	PEAK	H	30.0	-8.7	PASS
225.0	27.5	PEAK	V	30.0	-2.5	PASS
239.1	21.0	PEAK	H	37.0	-16.0	PASS
239.1	31.4	PEAK	V	37.0	-5.6	PASS
250.0	27.3	PEAK	V	37.0	-9.7	PASS
275.0	27.5	PEAK	V	37.0	-9.5	PASS
300.0	26.6	PEAK	V	37.0	-10.4	PASS
325.0	28.6	PEAK	V	37.0	-8.4	PASS
350.0	26.8	PEAK	V	37.0	-10.3	PASS
375.0	26.7	PEAK	V	37.0	-10.3	PASS
400.0	27.9	PEAK	V	37.0	-9.1	PASS

PULSE EKKO 100B- 50 MHz/ 400 Volt Pulser,

FREQUENCY (MHz)	RF LEVEL (dBuV/m)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	LIMIT (dBuV/m)	MARGIN (dB)	PASS/ FAIL
49.5	27.4	QP	V	30.0	-2.6	PASS
49.5	20.1	PEAK	H	30.0	-9.9	PASS
64.0	28.7	QP	V	30.0	-1.3	PASS
64.0	23.8	PEAK	H	30.0	-6.2	PASS
129.7	28.1	QP	V	30.0	-1.9	PASS
129.7	27.2	PEAK	H	30.0	-2.8	PASS
150.0	25.5	PEAK	V	30.0	-4.5	PASS
150.0	21.5	PEAK	H	30.0	-8.5	PASS
182.4	27.0	QP	V	30.0	-3.0	PASS
182.4	24.0	PEAK	H	30.0	-6.0	PASS
200.0	25.2	PEAK	V	30.0	-4.8	PASS
239.1	31.4	PEAK	V	37.0	-5.6	PASS
239.1	21.0	PEAK	H	37.0	-16.0	PASS
250.0	28.2	PEAK	V	37.0	-8.8	PASS
250.0	28.1	PEAK	H	37.0	-8.9	PASS
300.0	26.9	PEAK	V	37.0	-10.2	PASS
350.0	26.4	PEAK	V	37.0	-10.6	PASS
400.0	31.3	PEAK	V	37.0	-5.7	PASS

PULSE EKKO 100B- 50 MHz/ 1000 Volt Pulser,

FREQUENCY (MHz)	RF LEVEL (dBuV/m)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	LIMIT (dBuV/m)	MARGIN (dB)	PASS/ FAIL
49.5	20.1	PEAK	H	30.0	-9.9	PASS
49.5	27.4	QP	V	30.0	-2.6	PASS
50.0	25.2	PEAK	H	30.0	-4.8	PASS
50.0	25.5	QP	V	30.0	-4.5	PASS
64.0	23.8	PEAK	H	30.0	-6.2	PASS
64.0	28.7	QP	V	30.0	-1.3	PASS
129.7	27.2	PEAK	H	30.0	-2.8	PASS
129.7	28.1	QP	V	30.0	-1.9	PASS
150.0	26.9	PEAK	H	30.0	-3.2	PASS
150.0	28.2	QP	V	30.0	-1.8	PASS
182.4	24.0	PEAK	H	30.0	-6.0	PASS
182.4	27.0	QP	V	30.0	-3.0	PASS
200.0	26.4	QP	V	30.0	-3.6	PASS
239.1	21.0	PEAK	H	37.0	-16.0	PASS
239.1	31.4	PEAK	V	37.0	-5.6	PASS
250.0	21.5	PEAK	H	37.0	-15.5	PASS
250.0	31.3	PEAK	V	37.0	-5.7	PASS
300.0	22.9	PEAK	H	37.0	-14.1	PASS
300.0	28.1	PEAK	V	37.0	-8.9	PASS

PULSE EKKO 100B- 100 MHz/ 400 Volt Pulser,

FREQUENCY (MHz)	RF LEVEL (dBuV/m)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	LIMIT (dBuV/m)	MARGIN (dB)	PASS/ FAIL
49.5	27.4	QP	V	30.0	-2.6	PASS
49.5	20.1	PEAK	H	30.0	-9.9	PASS
64.0	28.7	QP	V	30.0	-1.3	PASS
64.0	23.8	PEAK	H	30.0	-6.2	PASS
129.7	28.1	QP	V	30.0	-1.9	PASS
129.7	27.2	PEAK	H	30.0	-2.8	PASS
182.4	27.0	QP	V	30.0	-3.0	PASS
182.4	24.0	PEAK	H	30.0	-6.0	PASS
200.0	27.6	QP	V	30.0	-2.4	PASS
239.1	31.4	PEAK	V	37.0	-5.6	PASS
239.1	21.0	PEAK	H	37.0	-16.0	PASS
300.0	27.4	PEAK	V	37.0	-9.7	PASS
400.0	29.1	PEAK	V	37.0	-7.9	PASS

PULSE EKKO 100B- 100 MHz/ 1000 Volt Pulser

FREQUENCY (MHz)	RF LEVEL (dBuV/m)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	LIMIT (dBuV/m)	MARGIN (dB)	PASS/ FAIL
49.5	27.4	QP	V	30.0	-12.6	PASS
49.5	20.1	PEAK	H	30.0	-19.9	PASS
64.0	28.7	QP	V	30.0	-11.3	PASS
64.0	23.8	PEAK	H	30.0	-16.2	PASS
129.7	28.1	QP	V	30.0	-11.9	PASS
129.7	27.2	PEAK	H	30.0	-12.8	PASS
182.4	27.0	QP	V	30.0	-13.0	PASS
182.4	24.0	PEAK	H	30.0	-16.0	PASS
239.1	31.4	PEAK	V	37.0	-15.6	PASS
239.1	21.0	PEAK	H	37.0	-26.0	PASS

PULSE EKKO 100B- 200 MHz/ 400 Volt Pulser,

FREQUENCY (MHz)	LEVEL (dBuV/m)	USED (PEAK/QP)	PLANE (H/V)	LIMIT (dBuV/m)	MARGIN (dB)	PASS/ FAIL
49.5	27.4	QP	V	30.0	-12.6	PASS
49.5	20.1	PEAK	H	30.0	-19.9	PASS
64.0	28.7	QP	V	30.0	-11.3	PASS
64.0	23.8	PEAK	H	30.0	-16.2	PASS
129.7	28.1	QP	V	30.0	-11.9	PASS
129.7	27.2	PEAK	H	30.0	-12.8	PASS
182.4	27.0	QP	V	30.0	-13.0	PASS
182.4	24.0	PEAK	H	30.0	-16.0	PASS
200.0	27.4	QP	V	30.0	-2.6	PASS
239.1	31.4	PEAK	V	37.0	-15.6	PASS
239.1	21.0	PEAK	H	37.0	-26.0	PASS

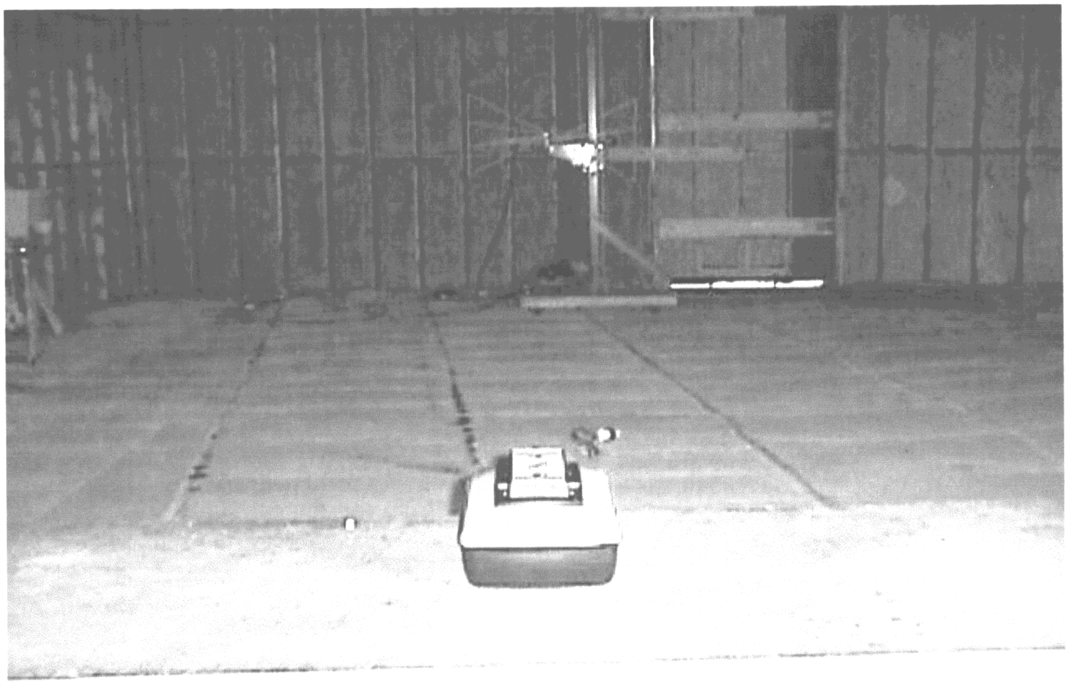
PULSE EKKO 100B- 200 MHz/ 1000 Volt Pulser,

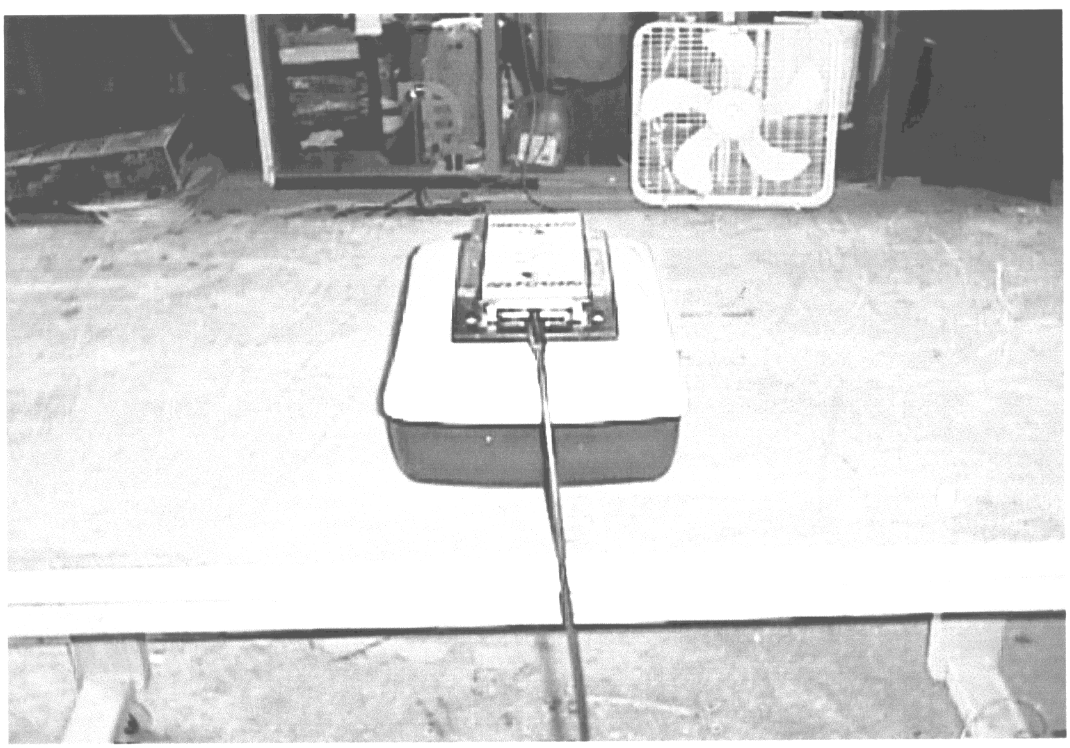
FREQUENCY (MHz)	LEVEL (dBuV/m)	USED (PEAK/QP)	PLANE (H/V)	LIMIT (dBuV/m)	MARGIN (dB)	PASS/ FAIL
49.5	27.4	QP	V	30.0	-12.6	PASS
49.5	20.1	PEAK	H	30.0	-19.9	PASS
64.0	28.7	QP	V	30.0	-11.3	PASS
64.0	23.8	PEAK	H	30.0	-16.2	PASS
129.7	28.1	QP	V	30.0	-11.9	PASS
129.7	27.2	PEAK	H	30.0	-12.8	PASS
182.4	27.0	QP	V	30.0	-13.0	PASS
182.4	24.0	PEAK	H	30.0	-16.0	PASS
200.0	28.8	QP	V	30.0	-1.2	PASS
239.1	31.4	PEAK	V	37.0	-15.6	PASS
239.1	21.0	PEAK	H	37.0	-26.0	PASS

PULSE EKKO 100B- 30-1000 MHz

FREQUENCY (MHz)	RF LEVEL (dBuV/m)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	LIMIT (dBuV/m)	MARGIN (dB)	PASS/ FAIL
49.5	27.4	QP	V	30.0	-12.6	PASS
49.5	20.1	PEAK	H	30.0	-19.9	PASS
64.0	28.7	QP	V	30.0	-11.3	PASS
64.0	23.8	PEAK	H	30.0	-16.2	PASS
129.7	28.1	QP	V	30.0	-11.9	PASS
129.7	27.2	PEAK	H	30.0	-12.8	PASS
182.4	27.0	QP	V	30.0	-13.0	PASS
182.4	24.0	PEAK	H	30.0	-16.0	PASS
239.1	31.4	PEAK	V	37.0	-15.6	PASS
239.1	21.0	PEAK	H	37.0	-26.0	PASS

TEST SETUP FOR
RADIATED EMISSIONS MEASUREMENTS
(tests were performed at the Open Field test Site located in Oakville, Ontario, Canada)





4181 Sladeview Cres., Unit 33, Mississauga, Ontario, Canada L5L 5R2
Tel. #: 905-569-2550, Fax. #: 905-569-2480, Wesite: http://www.ultratech-labs.com

3.8. Radiated Emissions Measurements

PRODUCT NAME: NOGGIN, Model No.: 500

FCC CLASS A LIMIT: FCC Part 15, Sub. B, Para. 15.109(b)

The RF radiated emissions measured at 3 meters distance shall not exceed the field strength below:

FREQUENCY (MHz)	FIELD STRENGTH LIMIT @ 3 meters (dBµV/m)
30 - 88	49.5
88 - 216	54.0
216 - 960	56.9
Above 960	60.0

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 23 °C
- Relative humidity: 43 %

POWER INPUT: 12Vdc battery

TEST EQUIPMENT:

- EMI Receiver System/Spectrum Analyzer, Hewlett Packard, Model 8546A, Input +25dBm max., 9KHz-5.6GHz, 50 Ohms, built-in Peak, Quasi-Peak & Average Detectors, Pre-Amplifier and Tracking Signal Generator. This System includes: (1) HP 85460A RF Filter Section, S/N: 3448A00236 and (2) HP 85462A Receiver RF Section/Display, S/N: 3520A00248.
- Spectrum Analyzer, Advantest, Model R3271, S/N: 15050203, 100 Hz to 32 GHz)
- Microwave Amplifier, HP, Model 8349A, SN: 2340A00206, Frequency Range 1 to 22 GHz, 30dB gain nominal.
- BiconiLog Antenna, Emco, Model 3142, SN 10005, 30-2000 MHz @ 50 Ohms.
  Log Periodic Antenna, AH System, Model SAS-200/518, SN: 343, Frequency Range: 1GHz-18GHz.
- FCC Listed Open Field Test Site.

METHOD OF MEASUREMENTS: Refer to ANSI C63.4-1992.

TEST RESULTS: Conforms

TEST PERSONNEL: **Mr. Vinh K. Ngo and Phu Luu, EMC Technician**

TEST DATE: **August 21, 1998**

MEASUREMENT DATA:

RADIATED EMISSIONS (@ 3 meters)

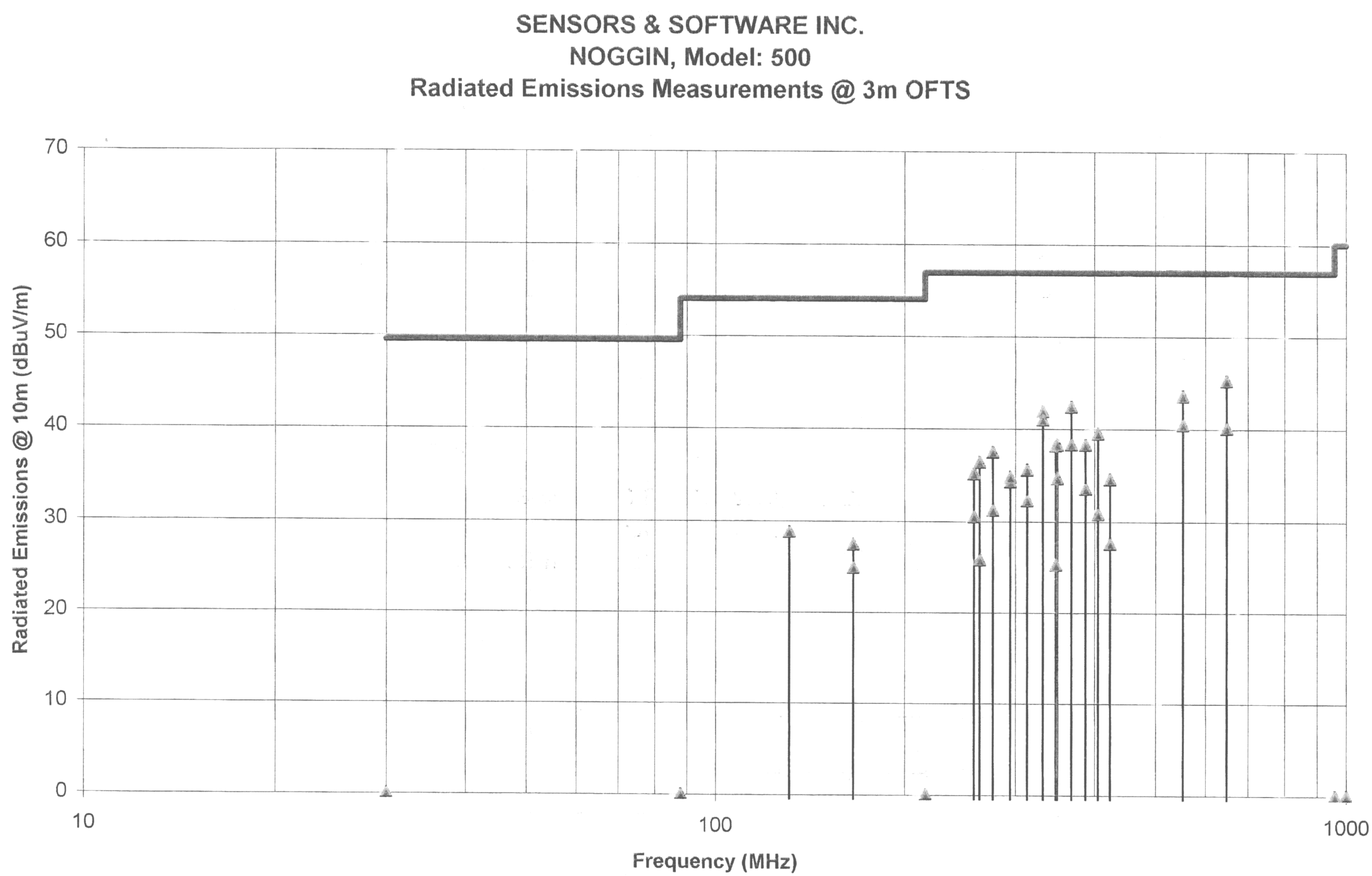
REMARKS

- *All rf emissions from 30 to 1000 MHz were scanned, and all emission levels greater than 30 dBµV/m were recorded.*
- *For Frequency range 30 - 1000 MHz*
  - ◊ *Peak Detector, 100KHz RBW, VBW ≥ RBW*
  - ◊ *CISPR QUASI-PEAK, 120KHz RBW, VBW ≥ RBW.*
- *For Frequency > 1 GHz*
  - ◊ *Peak Detector, 1 MHz RBW, 1 MHz VBW*

FREQUENCY (MHz)	RF LEVEL (dBuV/m)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	LIMIT (dBuV/m)	MARGIN (dB)	PASS/ FAIL
131.30	28.7	PEAK	V	54.0	-25.3	PASS
165.89	27.4	PEAK	V	54.0	-26.6	PASS
165.89	24.9	PEAK	H	54.0	-29.1	PASS
258.04	35.2	PEAK	V	56.9	-21.7	PASS
258.04	30.5	PEAK	H	56.9	-26.4	PASS
263.60	36.4	PEAK	H	56.9	-20.5	PASS
263.60	25.8	PEAK	V	56.9	-31.1	PASS
276.50	37.5	PEAK	V	56.9	-19.4	PASS
276.50	31.2	PEAK	H	56.9	-25.7	PASS
294.90	34.3	PEAK	V	56.9	-22.6	PASS
294.90	34.8	PEAK	H	56.9	-22.1	PASS
313.35	35.6	PEAK	V	56.9	-21.3	PASS
313.35	32.3	PEAK	H	56.9	-24.6	PASS
331.80	41.9	QP	V	56.9	-15.0	PASS
331.80	41.0	QP	H	56.9	-15.9	PASS
347.80	38.2	PEAK	H	56.9	-18.7	PASS
347.80	25.2	PEAK	V	56.9	-31.7	PASS
350.21	38.3	PEAK	V	56.9	-18.6	PASS
350.21	34.7	PEAK	H	56.9	-22.2	PASS
368.60	42.4	QP	V	56.9	-14.5	PASS
368.60	38.4	PEAK	H	56.9	-18.6	PASS
387.60	38.3	PEAK	V	56.9	-18.6	PASS
387.60	33.5	PEAK	H	56.9	-23.4	PASS
405.49	39.5	PEAK	V	56.9	-17.4	PASS
405.49	30.8	PEAK	H	56.9	-26.1	PASS

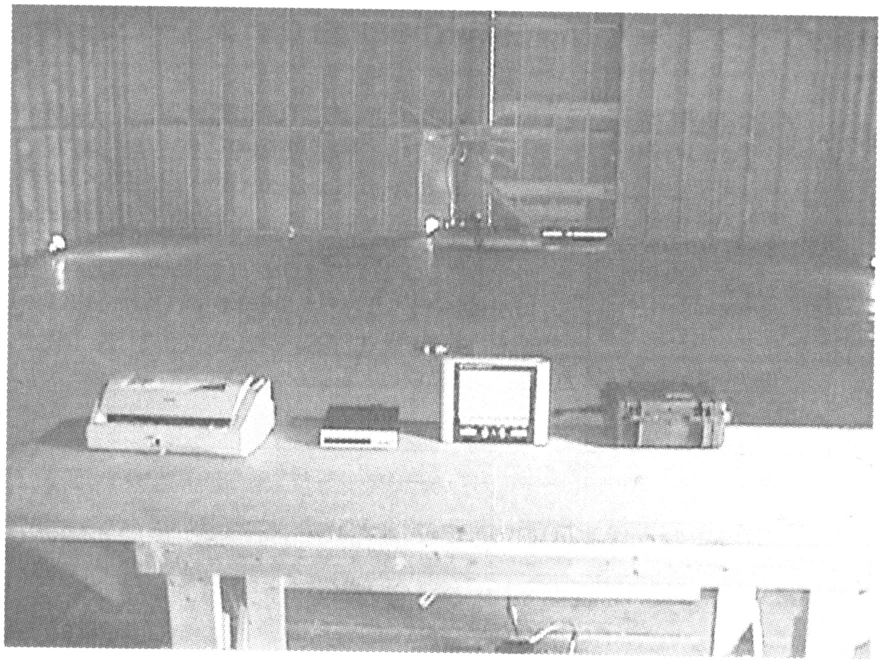
Continued…

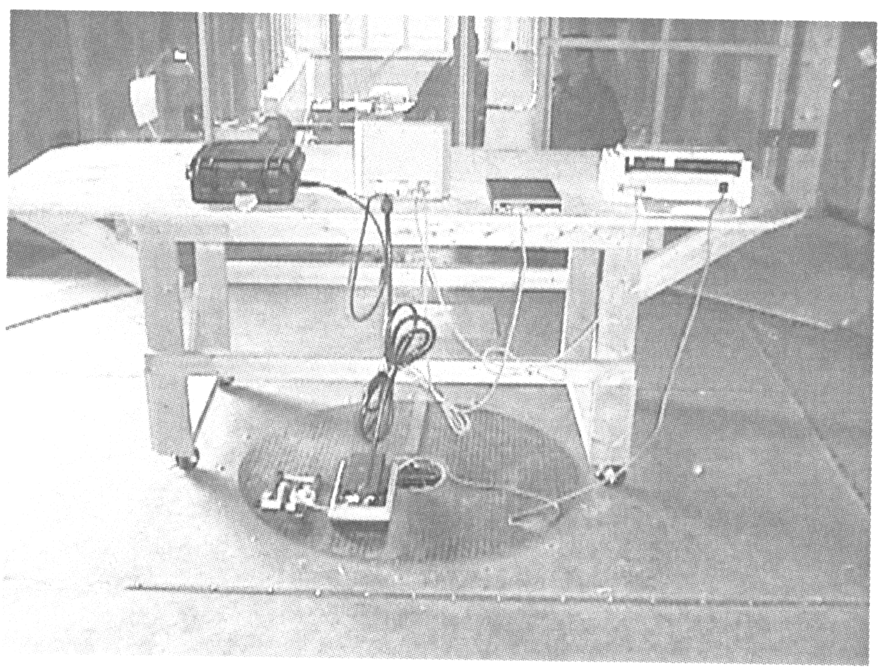
FREQUENCY (MHz)	RF LEVEL (dBuV/m)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	LIMIT (dBuV/m)	MARGIN (dB)	PASS/ FAIL
423.95	34.6	PEAK	V	56.9	-22.3	PASS
423.95	27.5	PEAK	H	56.9	-29.4	PASS
552.65	43.6	PEAK	H	56.9	-13.3	PASS
552.65	40.5	PEAK	V	56.9	-16.4	PASS
648.72	45.2	QP	V	56.9	-11.7	PASS
648.72	40.1	PEAK	H	56.9	-16.8	PASS


SENSORS & SOFTWARE INC.
NOGGIN, Model: 500
Radiated Emissions Measurements @ 3m OFTS
Radiated Emissions @ 10m (dBuV/m)
70
60
50
40
30
20
10
0
10
100
1000
Frequency (MHz)

5.5.6. *Photographs of Test Setup*

Refer to the following photographs for setup and arrangement of equipment under tests.





5.5. RADIATED EMISSIONS FROM CLASS A UNINTENTIONAL RADIATORS (DIGITAL DEVICES) @ FCC 15.109(B)

5.5.1. *Limits*

The equipment shall meet the limits of the following table:

Test Frequency Range (MHz)	Class A Limits @ 30 m (dBµV/m)	EMI Detector Used	Measuring Bandwidth (kHz)
30 – 88	29.1	Quasi-Peak	RBW = 120 kHz, VBW ≥ 120 kHz
88 – 216	33.5	Quasi-Peak	RBW = 120 kHz, VBW ≥ 120 kHz
216 – 960	36.4	Quasi-Peak	RBW = 120 kHz, VBW ≥ 120 kHz
Above 960	39.5	Average	RBW = 1 MHz, VBW = 1 Hz

5.5.2. *Method of Measurements*

Please refer to the Exhibit 7 of this test report and ANSI C63-4:1992 for radiated emissions test method.

The EUT shall be scanned from 30 MHz to the 5th harmonic of the highest oscillator frequency in the digital devices or 1 GHz whichever is higher.

5.5.3. *Test Equipment List*

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Advantest	R3271	15050203	100 Hz to 32 GHz with external mixer for frequency above 32 GHz
EMI Receiver System/Spectrum Analyzer	Hewlett Packard	HP 8546A	3520A00248	9KHz-5.6GHz, 50 Ohms
Microwave Amplifier	Hewlett Packard	HP 83017A	311600661	1 GHz to 26.5 GHz
Biconilog Antenna	EMCO	3143	1029	20 MHz to 2 GHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vhk.ultratech@sympatico.ca, Website: http://www.ultratech-labs.com

5.5.4. Test data

FREQUENCY (MHz)	RF LEVEL (dBuV/m)	DETECTOR USED (PEAK/QP)	ANTENNA PLANE (H/V)	LIMIT (dBuV/m)	MARGIN (dB)	PASS/ FAIL
31.60	21.1	PEAK	V	29.1	-8.0	PASS
31.60	10.0	PEAK	H	29.1	-19.1	PASS
31.79	25.3	PEAK	V	29.1	-3.8	PASS
31.79	12.2	PEAK	H	29.1	-16.9	PASS
33.50	23.2	PEAK	V	29.1	-5.9	PASS
33.50	14.2	PEAK	H	29.1	-14.9	PASS
44.13	24.5	PEAK	V	29.1	-4.6	PASS
44.13	12.6	PEAK	H	29.1	-16.5	PASS
104.23	18.6	PEAK	V	33.5	-14.9	PASS
104.23	16.7	PEAK	H	33.5	-16.8	PASS
105.26	19.3	PEAK	V	33.5	-14.2	PASS
105.26	18.6	PEAK	H	33.5	-14.9	PASS
106.29	19.6	PEAK	V	33.5	-13.9	PASS
106.29	18.7	PEAK	H	33.5	-14.8	PASS
107.40	18.4	PEAK	V	33.5	-15.1	PASS
107.40	15.3	PEAK	H	33.5	-18.2	PASS
112.35	19.5	PEAK	V	33.5	-14.0	PASS
112.35	15.7	PEAK	H	33.5	-17.8	PASS
183.26	22.6	PEAK	V	33.5	-10.9	PASS
183.26	14.6	PEAK	H	33.5	-18.9	PASS
192.40	19.3	PEAK	V	33.5	-14.2	PASS
192.40	9.2	PEAK	H	33.5	-24.3	PASS
195.79	25.9	PEAK	V	33.5	-7.6	PASS
195.79	15.3	PEAK	H	33.5	-18.2	PASS
199.89	22.8	PEAK	V	33.5	-10.7	PASS
199.89	15.8	PEAK	H	33.5	-17.7	PASS
200.71	19.5	PEAK	V	33.5	-14.0	PASS
200.71	8.0	PEAK	H	33.5	-25.5	PASS
208.33	25.0	PEAK	V	33.5	-8.5	PASS
208.33	17.2	PEAK	H	33.5	-16.3	PASS
220.86	23.5	PEAK	V	36.4	-12.9	PASS
220.86	17.1	PEAK	H	36.4	-19.3	PASS
332.40	23.6	PEAK	V	36.4	-12.8	PASS
332.40	12.1	PEAK	H	36.4	-24.3	PASS
515.30	27.0	PEAK	V	36.4	-9.4	PASS
515.30	27.4	PEAK	H	36.4	-9.0	PASS
925.00	29.0	PEAK	V	36.4	-7.4	PASS
925.00	31.0	PEAK	H	36.4	-5.4	PASS
The emissions were scanned from 30 MHz to 1 GHz at 30 meters distance and all emissions less than 30 dB below the limits were recorded.						

5.5.5. Plots

The following plots graphically represent the test results recorded in the above Test Data Table.